An Evaluation of Simulation - Based Teaching Intervention in Selective Topics of Cardiorespiratory System among First Year Medical Students - A Mixed Method Study

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ABSTRACT

Background: Simulation is increasingly recognized as a valuable pedagogical tool in medical education; however, its application in foundational physiology teaching remains underutilized in Phase I MBBS. Simulation-based learning, grounded in experiential learning theory, offers opportunities for contextual understanding, learner engagement, and safe clinical skill practice.

Methodology: A mixed method study with randomized cross-over design was conducted among first-year medical students to compare simulation-based education with conventional small-group teaching in selected cardiovascular and respiratory physiology topics. All eligible volunteers from two consecutive cohorts (total n=250) were included, following need analysis and a pilot phase. Students were allocated to intervention and control arms with subsequent cross-over, and learning outcomes were measured. Pre- and post-test assessments consisting of multiple-choice questions (MCQs), extended matching questions (EMQs) and script concordance test (SCT) measured immediate learning gain and long-term retention. Quantitative perceptions were captured using validated Likert-scale feedback, while qualitative insights from in-depth interviews underwent thematic analysis.

Results: A total of 206 students (Cohort-I) and 211 students (Cohort-II) participated across two academic batches. Both control and intervention groups demonstrated statistically significant improvement from pre- to post-test in cardiovascular (shock) and respiratory (lung) topics across two cohorts. Positive perception was obtained regarding simulation-based teaching especially as a better engaging teaching method.

Conclusion: Simulation-based teaching is feasible, well-accepted, and pedagogically advantageous for enhancing conceptual learning and retention in cardiovascular and respiratory physiology. These findings support integrating low-cost simulation into Phase I physiology curriculum in alignment with competency based medical education (CBME) objectives.

Key words: Simulation-based education, Physiology, Undergraduate medical education, early clinical exposure.

1. INTRODUCTION

1.1. Background of the study

According to adult learning theory, when the facts and concepts are presented in the appropriate context, when relevance of learning is emphasized and the content taught is in problem oriented mode, students learn the best. [1] However, till recently, in India, most of the pre-clinical education happened through didactic lectures and practical demonstrations. From the academic year 2019-2020 onwards medical education in India saw an introduction of new competency based medical education curriculum which stresses on early clinical exposure, electives, longitudinal care and outcome based undergraduate teaching of clinical skills. [2]

Simulation is defined as "a technique and not technology to replace or amplify real life experiences with guided experiences that evoke or replicate substantial aspect of real world in a fully interactive manner" or "the artificial representation of a real-world process to achieve educational goals via experimental learning". [3] Simulation in preclinical education or basic sciences subjects is not entirely a new concept. Anatomy uses cadavers to establish relationships, Physiology and Pharmacology have employed animal labs to simulate the physiologic responses to various pharmacological interventions. [4] These animal labs are helpful for enhancing lecture material by demonstrating core physiologic concepts like cardiac cycle curves and function, physiologic responses to altered homeostasis. However animal labs have their own limitations in terms of cost, time and ethical considerations.[5]

Simulation-based teaching has been mainly adopted in clinical specialties like intensive care medicine, anesthesia, obstetrics etc. Simulation is also used to teach clinical aspects of basic sciences subject like anatomy, physiology, pharmacology etc. Simulation based teaching is preferred in topics like cardiovascular and respiratory physiology when compared to other systems like endocrinology as it is easy to recreate the physiological changes in the simulated environment. Using simulation-based teaching for teaching basic science concepts to phase I medical students or pre-clinical students is still unexplored barring a few exceptions. Probable reasons for

this trend could be a lack of proper curriculum and trained faculty. Simulation-based teaching which is based on experiential learning and deliberate practice theories. On integrating simulation with other traditional teaching methods in basic science subjects can definitely improve student learning as it incorporates the concept of "learning by doing" thereby increasing the retention of learned knowledge and the concept of deliberate practice of the specific learning outcomes which are essential by learners to acquire an expertise in the specified field. [6]

1.2 Need for the study

The NMC curriculum (2019) emphasizes competency-based learning, integration, and skill acquisition. With traditional methods, teaching physiology concepts especially in respiratory and cardiovascular physiology can be challenging. Traditional classroom teaching including small group teaching does not allow for an immersive educational experience, which is a necessary component for adult learning.

Simulation-based methods can enhance active learning, clinical correlation, and skill training, which aligns with CBME goals. This can reduce the gap between theory to practice as Physiology is often taught through lectures and limited practical using charts, experiments on frogs and human volunteers. Simulation offers hands-on, experiential learning that helps students visualize dynamic physiological processes. Simulation-based tools can standardize teaching and reduce variability in demonstration quality, through a controlled design, repeatability and objectivity in scoring. Simulation-based learning will help the students to effectively practice patient care in simulated environments, thereby improving their conceptual and clinical skill knowledge.

1.3 Statement of the study

Physiology forms the foundation for understanding clinical medicine, yet traditional lecture and demonstration methods often fail to effectively connect theoretical knowledge with its clinical application. The recent shift toward Competency-Based Medical Education (CBME) in India emphasizes on horizontal and vertical integration teaching, skill-based learning, and early clinical exposure. Simulation-based teaching provides an opportunity to decrease this gap in translation

of knowledge by providing experiential, hands-on learning that replicates real-life physiological phenomena in a virtual environment which is safe and be controlled. Despite its proven success in clinical disciplines, the use of simulation for teaching core physiology concepts to first-year medical students remain limited. This study seeks to explore the effectiveness of simulation-based teaching as a complementary tool in physiology education, aiming to enhance conceptual understanding, learner engagement, and application of physiological principles.

2. AIM AND OBJECTIVES

Aim of the study

To determine the effectiveness of simulation-based small group teaching intervention in comparison to conventional teaching in chosen topics of cardiorespiratory system among first year undergraduate medical students.

Objectives

Primary objectives

1. To develop a simulation-based learning module on the topics -Work of breathing & Mechanisms of different types of shock.

2. To compare the knowledge gain: both immediate and long term among first year undergraduate medical students post simulation-based intervention on topics “Work of breathing and compliance” and “Physiological mechanisms underlying different types of shock “with non-simulation based small group teaching.

Secondary Objective

3. To obtain student feedback on simulation-based intervention in the chosen cardiovascular and respiratory topics.

3. RESEARCH QUESTION

Is simulation based small group teaching in cardiorespiratory topics more effective than conventional small group teaching in terms of knowledge gain?

How different is simulation-based teaching when compared to traditional small group teaching in cardiorespiratory physiology?

Study variables

The study includes the following variables

Independent variables:

Simulation-based teaching intervention, conventional/ traditional small group teaching, students in depth interview

Dependent Variables:

Immediate Knowledge Gain- Difference between pre- and post-test scores using multiple choice questions (MCQs), extended matching questions (EMQs), and Script Concordance Test (SCT).

Long-Term Knowledge Retention- Follow-up post-test (MCQ/EMQ/SCT) conducted several months after the intervention.

Student Engagement and Perception Structured feedback questionnaire (Likert scale 1–5) and qualitative data from group interviews.

Operational definitions

Simulation-based Education /Teaching: (SBE/SBT)

A learner-centred instructional method that uses computer-assisted, mannequin-based, or virtual simulation tools to recreate physiological processes or clinical scenarios in a controlled environment. It allows students to observe, interact, and apply theoretical knowledge through guided experiential learning.

Traditional/ conventional Teaching:

Refers to the conventional didactic method of instruction involving lectures, chalk-and-board teaching, and demonstrations using charts, graphs, and human/animal experiments typically used in physiology practical sessions.

Competency-Based Medical Education (CBME):

An outcome-oriented educational framework prescribed by the National Medical Commission (NMC, 2019) that focuses on the acquisition of specific knowledge, skills, attitudes, and competencies required for effective medical practice.

First-Year MBBS Students:

Learners enrolled in the initial phase of the Bachelor of Medicine and Bachelor of Surgery program, undergoing instruction in pre-clinical subjects such as Anatomy, Physiology, and Biochemistry.

Conceptual Understanding:

The degree to which students grasp the underlying physiological mechanisms and can apply theoretical knowledge to explain or analyse functional processes.

Immediate knowledge gain:

Improvement in students' post-test scores immediately after the simulation session compared to pre-test.

Long-term knowledge retention

The ability to recall and apply learned concepts after a defined period (in the 2nd year MBBS).

Student Engagement and Perception

The level of active participation, interest, and motivation demonstrated by students during learning sessions, as observed or reported through feedback questionnaires.

Effectiveness:

In this study, "effectiveness" refers to the measurable improvement in learning outcomes (knowledge scores, understanding, and engagement) following the

introduction of simulation-based teaching compared with conventional or traditional teaching methods.

Assumptions

1. It is assumed that all participating first-year MBBS students possess comparable baseline knowledge of cardiovascular and respiratory physiology, as they have undergone similar curricular exposure before the intervention.

2. It is assumed that simulation-based teaching provides a more engaging and interactive learning environment compared to conventional/ traditional lecture-based teaching.

3. It is assumed that any difference observed in post-test or long-term retention scores between the groups will primarily result from the teaching-learning method (simulation vs. non-simulation) rather than from extraneous factors.

4. It is assumed that low-cost, low-fidelity simulators and screen-based simulators can effectively demonstrate physiological concepts similar to higher-fidelity models when used with guided discussion.

5. It is assumed that faculty members participating in simulation sessions are adequately trained and will adhere to the facilitator checklist to maintain uniformity in delivery.

Summary

Physiology is a core pre-clinical subject that bridges basic science and clinical medicine. Traditional lecture-based teaching often emphasizes rote memorization and limits students' ability to visualize dynamic physiological processes. With the introduction of the Competency-Based Medical Education (CBME) curriculum by the National Medical Commission (NMC) in 2019, there is a growing emphasis on learner-centered, integrated, and skill-based learning approaches. Simulation-based teaching provides experiential, hands-on learning opportunities that align with these CBME principles by enabling students to *"learn by doing."*

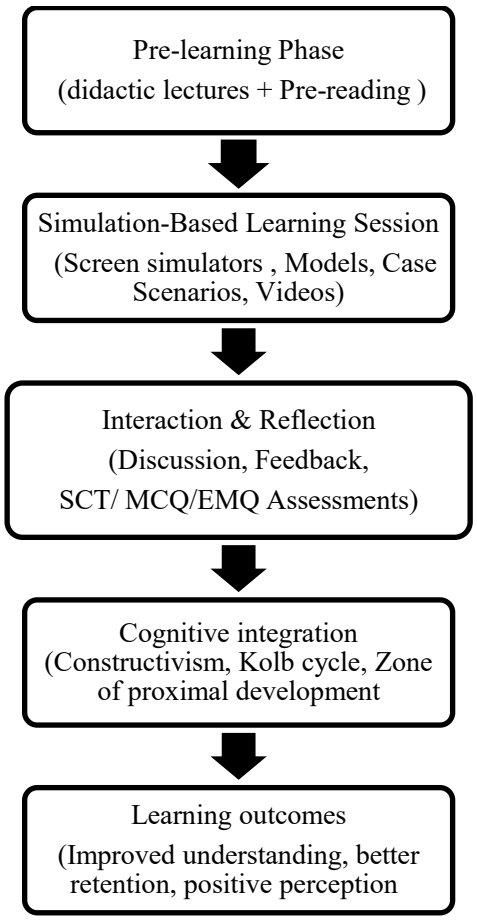
The present mixed-method with randomized controlled crossover study titled **"**An evaluation of simulation-based teaching intervention in selective topics of cardiovascular and respiratory system among first-year medical students**"** aims to determine the effectiveness of simulation-based teaching compared to non-simulation teaching. Simulation modules were developed for the topics *Work of Breathing and Compliance* (respiratory system) and *Mechanisms of Shock* (cardiovascular system).

The study involves first-year MBBS students divided into intervention (simulation-based education) and control (non-simulation-based education) groups. Both immediate and long-term knowledge gains are assessed through multiple tools such as MCQs, Extended Matching Questions (EMQs), and Script Concordance Tests (SCTs). Student feedback. are obtained through structured questionnaires and in-depth interviews.

The outcomes of this study are expected to provide an insight on the educational value of simulation in teaching complex physiological concepts, and its role in improving conceptual understanding, engagement, and retention, and its feasibility for integration into Phase-I MBBS physiology curriculum in alignment with CBME guidelines.

4. REVIEW OF LITERATURE

Figure 1 Theoretical Framework of Simulation-Based Learning in Cardiorespiratory Physiology



Theoretical Framework for Simulation-Based Teaching in Cardiorespiratory Physiology

This study is grounded in the principles of Constructivist Learning Theory (CLT), which proposes that learners build knowledge actively through experience rather than passive reception. In line with Kolb's Experiential Learning Cycle and the CLT, where visualization and use of models reduce intrinsic load on the students and improve comprehension of complex physiological processes**.** The students obtain conceptual input through didactic lectures and pre-reading assignments which can be termed as Concrete Experience followed by participation in hands-on simulation activity which is equivalent to active experimentation by the student and Reflective Observation is attained when student reflects on outcomes of this experience during

the discussions and feedback sessions with the facilitators , and finally Abstract Conceptualization occurs during application of the integrated understanding happens during the assessments. Since the study is designed to happen in small groups, this helps in promoting peer assisted learning (PAL) and collaboration among the learners supporting the theory of zone of proximal development. [7]

SBE for pre-clinical/basic science learning (physiology)

Studies and reviews report that simulation (mannequin, screen-based, mechanical models) can help students visualize dynamic physiological processes, improve conceptual understanding, and facilitate integration of basic science with clinical reasoning. [8] This is particularly true for dynamic systems like cardiovascular and respiratory physiology where time-based interactions for example compliance, shock responses are difficult to convey in lectures alone. [9]

Mode of SBE (High versus low- and screen-based fidelity approaches)

Recent work emphasizes that fidelity (high vs low) is not the sole determinant of learning rather careful instructional design, aligned objectives, deliberate practice and debriefing matter more. Low-cost mechanical trainers and screen-based platforms have been shown to be effective for conceptual teaching when coupled with guided facilitation. Reviews recommend scalable, context-appropriate solutions especially for resource-limited settings. [10]

A study done by Suvarna P, on the first-year undergraduate medical students, for teaching cardiovascular physiology principles with the help of high-fidelity simulator concluded that learning with the help of simulation-based activities can help the students to link the basic science concepts to their practical applications. [11]

Evidence for learning outcomes: immediate gain and retention

Recent quasi-experimental and randomized educational trials show that SBE leads to greater immediate learning gains compared with traditional methods in many settings, and emerging evidence indicates improved short -term retention. [12,13] Several systematic and scoping reviews (2023–2025) synthesize quasi-experimental studies and report modest–moderate effect sizes for knowledge and skills, while also calling for more rigorous designs and longer follow-up for retention outcomes. [14]

Evidence for student perceptions on SBE

Recent studies consistently report high learner satisfaction and perceived usefulness of simulation for understanding complex, dynamic physiology. Faculty feedback studies indicate perceived feasibility and educational value but also highlight barriers such as faculty time, training needs, infrastructure, and scheduling. These themes are echoed across Indian and international studies. [15]

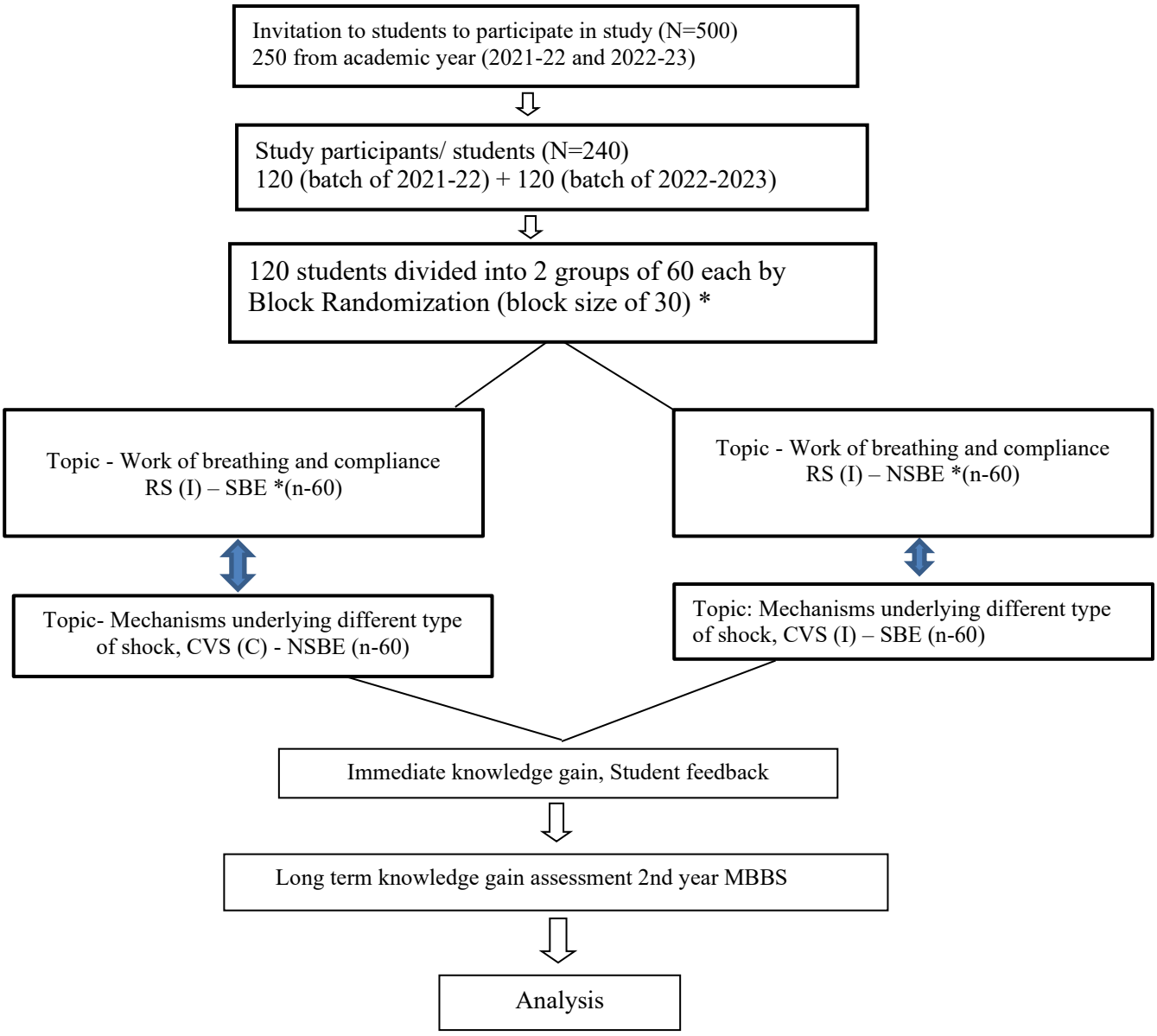
Evidence for Methodological gaps and research priorities in SBE

Recent scoping/systematic reviews repeatedly identify common limitations: heterogeneous outcome measures (knowledge vs skills vs attitudes), short follow-up periods, variable randomization/blinding, underreporting of effect sizes, and limited cost-effectiveness data. They recommend more randomized control trial (RCTs) or well-designed quasi-experimental studies in pre-clerkship populations, standardization of assessments tool, and mixed-method evaluations to capture acceptability and implementation barriers. [16]

5. RESEARCH METHODOLOGY

This chapter outlines the research methodology employed, to determine the effectiveness of simulation-based teaching intervention in comparison to non-simulation-based teaching in chosen topics of cardiovascular and respiratory system among first year undergraduate medical students. It encompasses the research design, setting, sample, and study population, study tool, the procedure of the study, ethical considerations, and data analysis.

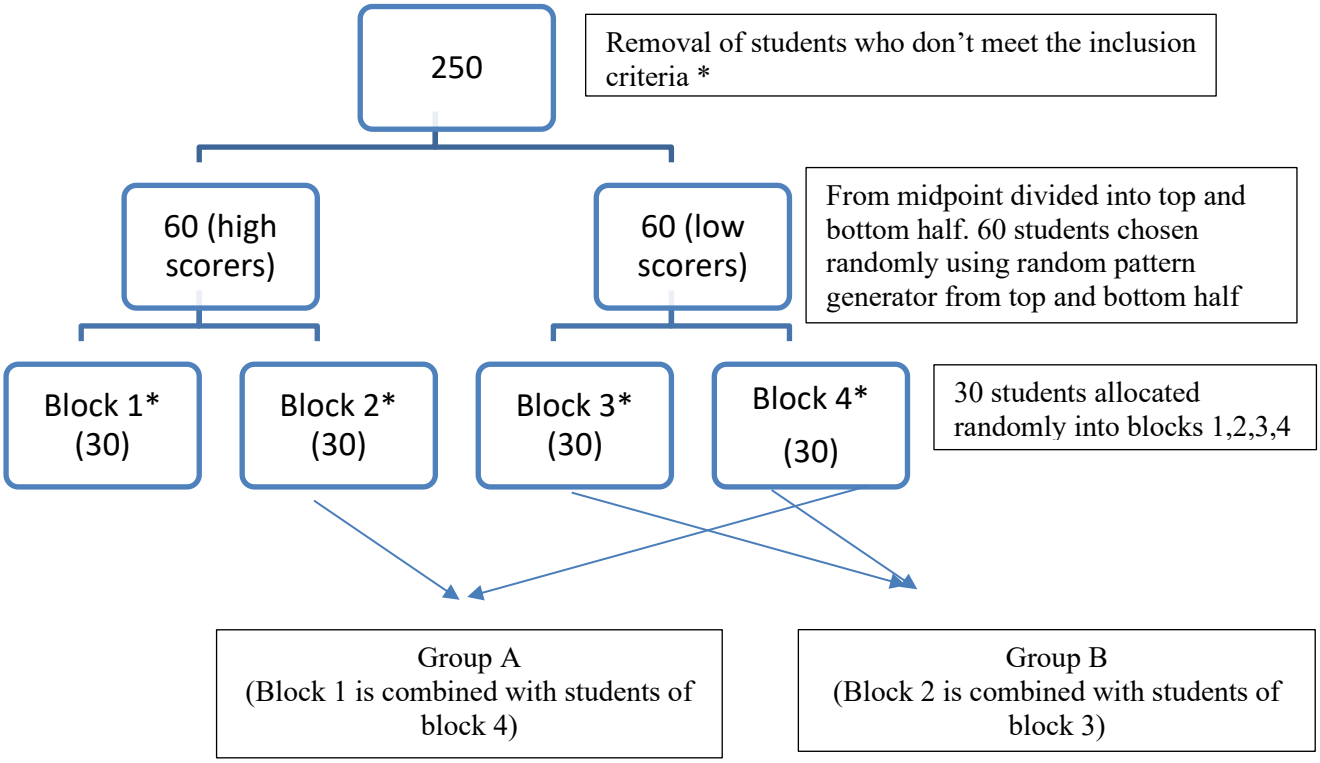
Figure 2: Flow chart depicting methodology


Invitation to students to participate in study (N=500)
250 from academic year (2021-22 and 2022-23)
Study participants/ students (N=240)
120 (batch of 2021-22) + 120 (batch of 2022-2023)
120 students divided into 2 groups of 60 each by Block Randomization (block size of 30) *
Topic - Work of breathing and compliance
RS (I) – SBE *(n-60)
Topic - Work of breathing and compliance
RS (I) – NSBE *(n-60)
Topic- Mechanisms underlying different type of shock, CVS (C) - NSBE (n-60)
Topic: Mechanisms underlying different type of shock, CVS (I) – SBE (n-60)
Immediate knowledge gain, Student feedback
Long term knowledge gain assessment 2nd year MBBS
Analysis

- * Block randomization is described in the next table

SBE- simulation based education, NSBE- non-simulation-based education

Figure 3: Block randomization based on stratified sampling


250
Removal of students who don't meet the inclusion criteria *
60 (high scorers)
60 (low scorers)
From midpoint divided into top and bottom half. 60 students chosen randomly using random pattern generator from top and bottom half
Block 1* (30)
Block 2* (30)
Block 3* (30)
Block 4* (30)
30 students allocated randomly into blocks 1,2,3,4
Group A (Block 1 is combined with students of block 4)
Group B (Block 2 is combined with students of block 3)

Block 1 – top 30 scoring students among the high scorers

Block 2- bottom 30 scoring students among the high scorers

Block 3 – top 30 scoring students among the low scorers

Block 4- bottom 30 scoring students among the low scorers

*13 & 11 students in cohort I & II respectively

a. **Type of Study:** Mixed method (Randomized control study with cross over design & in-depth interview)

b. **Study Population:** Phase 1 (first year) medical undergraduate students from

   Mahatma Gandhi Medical College and Research Institute.

c. **Duration of the study:** 4 years

d. **Sample size calculation: -** Sample size was calculated based on the difference in means in outcomes between two groups. Expecting a difference of 25 percent between the groups with a case to control ratio of 1:1 at a Confidence interval of 95% and study powered at 80%, the sample size was determined to be 59 in each group. The total sample size was estimated as 120. The sample size was calculated using Open Epi software version 3.01

e. Selection Criteria

a) Inclusion Criteria:

Phase I medical students of the academic year 2021-2022 and 2022-2023 who volunteer to participate in the study by signing the informed consent.

b) Exclusion Criteria:

- Students who did not attend the necessary number of assessments during the first-year physiology course at the time of intervention. (minimum three out of four)

d. Method of data Collection:

Step 1: Need analysis

To finalize on the topics needed for intervention, faculty opinion on topics in cardiovascular and respiratory physiology which required more resources in terms of models, videos was collected. Based on the topics provided by faculty student opinion was taken through an online survey to rate the listed topics in terms of difficulty in understanding the concepts.

Step 2: Pilot study

On a group of 20 students not part of the study population, a pilot session was conducted and their feedback was collected on the process, assessments tools, and feasibility regarding the simulation-based intervention.

Step 3: Intervention

The module was developed with goals and learning objectives for both simulations based small group teaching sessions with defined with specific learning outcomes, facilitator guided discussion and assessment methods.

A plan was prepared for the pre and posttest, instructions, simulations-based teaching, feedback. A team of simulation educators were trained by the primary investigator for the implementation of SBE. Students were introduced to the respiratory topics of "Work of breathing and compliance of lung" and cardiovascular topic of "Mechanisms underlying different type of shock" of by didactic lecture. Details regarding the formation of two groups control and intervention consisting of equal number of high and low scorers is given in the form of flow chart at the end of methodology section. Institutional ethical clearance was obtained before execution of the study (MGMCRI/RAC/2021/02/IHEC/10)

Phase I: At the simulation center

Topic: "Work of breathing and compliance of lung"

The students (group A = 60) were given an orientation to the learning outcomes, the working of the lung models for 20 minutes, including hands-on experience with techniques and models. The students were then divided into three groups of 20 each having a team leader to facilitate group interaction. Group B was exposed to conventional small group teaching method wherein the facilitator discussed the key points on the specified topic, directed student textbook reading and followed by question and answer session. Evaluation was done after the intervention to determine immediate knowledge gain by administering pretest and posttest consisting 20 multiple choice questions (MCQ), two sets of extended matching questions (EMQ) and script concordance test (SCT). Student feedback was collected at the end of the intervention. Long term knowledge gain was collected by administering the same assessment but shuffled tool within the first six months of second year MBBS.

Cross over: At the simulation center

Topic – "Mechanisms underlying different type of shock"

The students (group B = 60) were given a briefing about the learning outcomes, the working of screen simulators for 20 minutes. This included hands-on experience with techniques and working of the models. The students were then divided into three groups of 20 each having a team leader to facilitate group interaction. Group A was exposed to conventional small group teaching wherein the facilitator discussed the key points on the topic, directed student textbook reading and followed by question and answer session. Evaluation was done by administering pretest and posttest consisting 20 MCQ, two sets of extended matching questions (EMQ) and script concordance test (SCT) after intervention to determine immediate knowledge gain. Long term knowledge gain was collected by administering the assessment tool (shuffled) within the first six months of second year MBBS.

Student Feedback survey (quantitative)

Students feedback regarding the simulation-based education were collected through a self-administered structured questionnaire using an anonymous online survey with a 5-point Likert scale ranging from strongly agree to strongly disagree. A pilot study was conducted on 20 first-year medical students who were not part of the study population to prepare the questionnaire and validate it. Based on their feedback, modifications were made to a few questions.

Procedure of the in-depth interviews (qualitative)

In-depth interviews were conducted by faculty member from the Department of Community Medicine, who is trained in qualitative interviewing in the presence of primary investigator. A purposive sampling approach was adopted which ensured the representation from both high- and low-scoring groups. Ten student volunteers were selected to explore their attitudes, behaviours, and perceptions regarding the simulation-based teaching intervention.

Interviews were scheduled at times convenient for both the students and the facilitator.

A structured interview guide was prepared, and written informed consent was obtained from all the participants. In total four interview were conducted, two each in the first and second cohorts respectively. Each interview, which lasted approximately 50 minutes, involved discussing eight guide questions. The discussions were documented by a scribe and were digitally audio-recorded. Interviews continued until saturation of key concepts was reached. The interviews recorded in digital audio format were transcribed verbatim, and the anonymized transcripts were verified against the handwritten notes by the scribe before analysis. The transcripts of the interviews were analysed by two independent reviewers. Broad themes, categories and important codes were generated from the transcripts and a common consensus was obtained between two reviewers with the help of the third reviewer. The themes, categories and codes generated in the in-depth interview are summarized in table 13 and 14 under results section.

Step 4: Analysis of data collected

Statistical analysis

The quantitative data was entered in Microsoft excel and analyzed using standard statistical packages (SPSS version 23). The data is presented in standard/median for quantitative variables. Student t test is used to compare within the group scores and independent t test is used to compare the scores between the groups and p value ≤ 0.05 is considered to be statistically significant. Thematic analysis was done for qualitative data derived from in depth interviews.

6. RESULTS

In the study, a total of 206 and 211 students participated in cohort I & II. In Cohort I, there were 99 participants with CVS shock (47 in the control group and 52 in the intervention group) and 107 with RS lung (52 control, 55 intervention). In Cohort II, there were 100 CVS shock (57 control, 43 intervention) and 111 RS lung (56 control, 55 intervention).

Two physiology modules Work of breathing and lung compliance and Mechanisms of shock were taught using simulation-based small-group teaching and conventional methods in a cross-over manner. Pre- and post-tests (MCQ, EMQ, SCT) assessed immediate and long-term knowledge gain. Student feedback was collected using a validated five-point Likert scale questionnaire. Quantitative data were analysed using SPSS, student & independent t-tests were applied with tests of significance at $p \leq 0.05$. Additionally, four in-depth qualitative interviews were conducted with selected volunteers to explore perceptions of the intervention, with transcripts thematically analysed.

Results of first cohort

Batch of 2021-22

Cardiovascular shock (CVS- shock) & Respiratory physiology of work of breathing (RS lung)

Table 1: Comparison of pretest with post test scores in control and intervention groups in CVS- shock (2021-22)

Groups	**Pretest (%) score (Mean± SD)**	**Posttest (%) score (Mean± SD)**	**Mean Difference (Mean± SD)**	**T-test (paired) *p*-value**
Control (47)	33.14 ± 11.8	49.65 ± 10.3	16.51 ± 12.6	t is 8.97 *p*= .00001.
Intervention (52)	32.84 ± 15.2	55.4 ± 13.5	22.56 ± 11.1	t is 14.718 *p*< .00001
Ind T-test *p*-value	The t-value is 0.10813. *p*-value .457059	t = 2.3633 *p* value 0.020	t = 2.5399 *p* value 0.0127	

Both groups showed significant improvement from pre- to post-test; however, the intervention group demonstrated a greater and statistically significant improvement. Independent t-test on gain scores was significant (p = 0.0127), indicating superior immediate retention in intervention group.

Table 2: Comparison of long-term scores (% retention) in control and intervention groups in CVS- shock (2021-22)

Groups	Posttest (%) score (Mean± SD)	Long term score (%) (Mean± SD)	% retention (Mean ± SD)
Control (43)	43.3 ± 9	30.6 ± 15.3	71.1 ± 33.5
Intervention (45)	46.7 ± 14.1	36.2 ± 14.7	85.9 ± 44.7
Ind T-test *p*-value	The t-value is -1.75281. *p*-value is .0416.		

Although both groups showed a decline from post-test to long-term scores, higher retention percentages are observed in intervention group and the difference was statistically significant (t = –1.75, p = 0.0416)

Table 3: Comparison of pretest with post test scores in control and intervention groups in RS lung (2021-22)

Groups	Pretest (%) score (Mean± SD)	Posttest (%) score (Mean± SD)	Mean Difference (Mean± SD)	T value (paired) p-value
Control (52)	37.9 ± 8.2	46.43 ± 7.7	8.53 ± 5.5	-5.47614 p <0.05
Intervention (55)	36.2 ± 9.9	47.16 ± 10.8	11.01 ± 8.6	-5.57588 p<0.05
Ind T-test p-value	t = 0.9643 p value 0.3371	t = 0.4005 p value 0.6896	t = 1.7657 p value 0.0804	

Both groups showed significant improvement from pre- to post-test; however, between-group comparisons for pretest, post-test, and gain scores were not statistically significant (p > 0.05), suggesting comparable immediate retention in control and intervention groups**.**

Table 4: Comparison of long-term scores (% retention) in control and intervention groups in RS lung (2021-22)

Groups	Posttest (%) score (Mean± SD)	Long term score (%) (Mean± SD)	% retention (Mean ± SD)
Control (30)	47.5 ± 8.4	30.9 ± 9.7	65.9 ± 21.1
Intervention (41)	48.7 ± 10.1	32.4 ± 12	66.7 ± 19.5
Ind T-test p-value	t = 0.1649 p -value 0.8695		

Long term retention percentages were similar in control and intervention groups and the difference is not statistically significant ($p > 0.05$),

Results of second cohort

Batch of 2022-23

Cardiovascular shock (CVS- shock) & Respiratory physiology of work of breathing (RS lung)

Table 5: Comparison of pretest with post test scores in control and intervention groups in CVS- shock (2022-23)

Groups	Pretest (%) score (Mean± SD)	Posttest (%) score (Mean± SD)	Mean Difference (Mean± SD)	T-test (paired) *p*-value
Control (57)	54.46±12.7	66.84±8.83	12.38±11.44	t = 6.0417. $p < .00001$.
Intervention (43)	54.66±12.4	68.79±11.1	14.13±7.45	t= 3.40303. $p = .000512$
Ind T-test *p*-value	t = 0.0788 *p* value 0.9374	t = 0.9784 *p* value 0.3303	t = 0.8726 *p* value 0.3850	

Both groups showed statistically significant improvement from pre- to post-test; but independent t-tests for pretest, post-test, and gain scores showed no significant difference ($p > 0.3$), indicating similar immediate retention in control and intervention group.

Table 6: Comparison of long-term scores (% retention) in control and intervention groups in CVS- shock (2022-23)

Groups CVS	Posttest (%) score (Mean± SD)	Long term score (%) (Mean± SD)	Retention (%) (Mean± SD)
Control (26)	66.6 ± 10.1	43.57 ± 21.2	65.6 ± 31.4
Intervention (26)	67.85 ± 9.1	53.18 ± 17.1	77.6 ± 21.4
Ind T-test *p*-value	t = 1.6103 *p* value 0.1136		

Although both groups showed a decline from post-test to long-term scores, higher retention percentages are observed in intervention group, but the difference was not statistically significant (p = 0.113)

Table 7: Comparison of pretest with post test scores in control and intervention groups in RS lung (2022-23)

Groups	Pretest (%) score (Mean± SD)	Posttest (%) score (Mean± SD)	Mean Difference (Mean± SD)	T value (paired) p-value
Control (56)	51.06±14.36	64.74±11.03	13.67±13.49	t = 7.5808 *p* = 0.0001
Intervention (55)	44.67±18.72	61.97±9.98	17.3 ± 16.74	t = 6.0475 *p* =0.0001
Ind T-test *p*-value	t = 2.0224 *p* value 0.0456	t = 1.3504 *p* value 0.18	t = 1.2504 *p* value 0.2	

Both groups showed significant improvement from pre- to post-test; however, between-group comparisons for pretest, post-test, and gain scores were not statistically significant (p > 0.2), suggesting comparable immediate retention in control and intervention groups.

Table 8: Comparison of long-term scores (% retention) in control and intervention groups in RS lung (2022-23)

Groups	Posttest (%) score (Mean± SD)	Long term score (%) (Mean± SD)	Retention (%) (Mean± SD)
Control (31)	67 ± 7.9	31.92 ± 14.6	47.74 ± 20.7
Intervention (39)	61.1 ± 10.5	28.7 ± 10.4	49.8 ± 24.8
Ind T-test *p*-value	t = 0.3781 p value 0.7		

Long term retention percentages were similar in control and intervention groups and the difference between the groups is not statistically significant (p = 0.7)

Student feedback- Cohort I

Table 9: Student feedback – CVS shock 21-22 (n=46)					
Questions	**Strongly Agree**	**Agree**	**Undecided**	**Disagree**	**Strongly Disagree**
The objectives of the session were clearly defined to me	30	14	2	0	0
I enjoyed the teaching session.	34	11	1	0	0
The time duration of the session was adequate according to me	24	17	3	2	0
I went through pre reading assignments provided to me (yes/no)	Yes (31) No (15)				
If yes Pre reading assignments prepared me for the topic	16	10	4	1	0
Didactic lecture on shock" helped me to get most of this session.	29	14	2	1	0
I am more confident in my understanding of the subtopic physiological mechanism of different types of shock	25	16	2	2	0

I am more confident in my ability to differentiate between different types of shock	28	16	1	0	0
This session made me more involved when compared to didactic classes.	27	14	2	1	0
I would prefer to have more of traditional teaching methods when compared to simulation-based teaching.	12	11	7	8	0
I would you like to learn other topics in a similar mode of teaching.	32	12	2	0	0
This session made me curious to know more about the subject.	31	11	4	0	0
This session helped me acquire new knowledge.	29	16	3	0	0
Facilitator oversaw time management well.	24	16	5	0	0
Facilitator helped us to understand the topic better.	33	10	1	0	0
Facilitator encouraged us to ask questions.	29	15	3	1	0
Facilitator made the class interactive.	35	8	2	0	0
Facilitator provided me the chance to participate during the session	35	7	2	1	0
What were the facilitating factors of learning? *					
What were the hindering factors for learning? *					

***Two open ended questions**

Table 10: Student feedback – RS lung 21-22 (n=42)					
Questions	**Strongly Agree**	**Agree**	**Undecided**	**Disagree**	**Strongly Disagree**
The objectives of the session were clearly defined to me.	29	9	4	0	0
I enjoyed the teaching session.	32	7	3	0	0
The time duration of the session was adequate according to me.	27	12	2	0	0
I went through pre reading assignments provided to me (yes/no)	Yes (36) No (6)				
Pre reading assignments prepared me for the topic	14	12	10	0	0
Didactic lecture on Compliance and Work of breathing helped me to get most of this session.	24	13	5	0	0
I am more confident in my understanding of the subtopic compliance of lung	21	19	2	0	0
I am more confident in my ability to understanding of the subtopic resistance to air flow.	24	16	2	0	0
I am more confident in my ability to understanding of the subtopic work of breathing	18	19	5	0	7
I would prefer to have more of traditional teaching methods when compared to simulation-based teaching.	13	8	5	9	0
I would you like to learn other topics in a similar mode of teaching.	25	14	2	1	0
This session made me curious to know more about the subject.	26	10	5	1	0
This session helped me acquire new knowledge.	24	17	1	0	1
Facilitator oversaw time management well	29	11	2	0	0
Facilitator helped us to understand the topic better.	32	8	2	0	0
Facilitator encouraged us to ask questions.	33	7	1	0	0
Facilitator showed enthusiasm.	33	7	1	1	1
Facilitator made the class interactive.	33	7	2	0	0

***Two open ended questions**

Student feedback- Cohort II

Table 11: Student feedback – CVS shock 22-23 (n=50)					
Questions	**Strongly Agree**	**Agree**	**Undecided**	**Disagree**	**Strongly Disagree**
The objectives of the session were clearly defined to me	40	6	1	1	2
I enjoyed the teaching session.	43	3	1	1	2
The time duration of the session was adequate according to me	36	9	1	2	2
I went through pre reading assignments provided to me (yes/no)	Yes (44) No (6)				
If yes Pre reading assignments prepared me for the topic	22	8	3	5	6
Didactic lecture on shock" helped me to get most of this session.	33	2	2	7	6
I am more confident in my understanding of the subtopic physiological mechanism of different types of shock	35	3	2	4	6
I am more confident in my ability to differentiate between different types of shock	33	3	3	6	5
This session made me more involved when compared to didactic classes.	37	2	1	5	5
I would prefer to have more of	16	8	4	6	16

traditional teaching methods when compared to simulation-based teaching.					
I would you like to learn other topics in a similar mode of teaching.	36	1	3	5	5
This session made me curious to know more about the subject.	37	2	2	3	5
This session helped me acquire new knowledge.	37	1	2	3	5
Facilitator oversaw time management well.	35	2	2	5	5
Facilitator helped us to understand the topic better.	39	2	1	2	6
Facilitator encouraged us to ask questions.	39	2	2	2	5
Facilitator made the class interactive.	40	1	2	1	6
Facilitator provided me the chance to participate during the session	39	1	3	2	5

***Two open ended questions**

Table 12: Student feedback – RS lung 22-23 (n=54)					
Questions	**Strongly Agree**	**Agree**	**Undecided**	**Disagree**	**Strongly Disagree**
The objectives of the session were clearly defined to me.	44	9	0	1	0
I enjoyed the teaching session.	39	13	2	0	0
The time duration of the session was adequate according to me.	30	15	8	1	0
I went through pre reading assignments provided to me (yes/no)	Yes (50) NO (4)				
Pre reading assignments prepared me for the topic	24	20	6	0	0
Didactic lecture on Compliance and Work of breathing helped me to get most of this session.	34	17	3	0	0
I am more confident in my understanding of the subtopic compliance of lung	32	17	5	0	0
I am more confident in my ability to understanding of the subtopic resistance to air flow.	35	18	1	0	0
I am more confident in my ability to understanding of the subtopic work of breathing	27	7	6	7	7
I would prefer to have more of traditional teaching methods when compared to simulation-based teaching.	39	11	3	1	0
I would you like to learn other topics in a similar mode of teaching.	39	14	1	0	0
This session made me curious to know more about the subject.	39	14	1	0	0
This session helped me acquire new knowledge.	40	12	1	0	1
Facilitator oversaw time management well	30	17	6	1	0
Facilitator helped us to understand the topic better.	37	17	0	0	0
Facilitator encouraged us to ask questions.	38	14	2	0	0
Facilitator showed enthusiasm.	38	14	1	0	1
Facilitator made the class interactive.	37	16	1	0	0

***Two open ended questions**

Table 13: Thematic analysis – Cohort I (CVS shock and RS lung)

Codes	Category	Themes
Clinical relevance, Case based scenarios, Models, Visualization, Knowledge application, Demonstration Video	Teaching learning tools	Facilitators of learning
Clear, Feedback, Small group Interaction, Individual attention, Discussion, Topics Sequence	Teaching Learning Process	
Stimulus, Instructions History taking, Curiosity	Assignments and Assessments	
Unfamiliar	Duration and timings •	Barriers of learning
Not sufficient, Overlap with another subject's test	Placement of intervention	

Table 14: Thematic analysis of Cohort II (CVS shock and RS lung)

Codes	Category	Themes
Clinical relevance, Case based scenarios, Models, Visualization, Knowledge application, Demonstration Video	Teaching learning tools	Facilitators of learning
Clear, Feedback, Small group Interaction, Individual attention, Discussion, Topics Sequence, no scolding, sufficient time, placement of intervention, not sleepy	Teaching Learning Process	
Stimulus, Instructions History taking, Curiosity	Assignments and Assessments	
Unfamiliar, difficult,	Assessment •	Barriers of learning

OVERALL SUMMARY

1. Immediate Learning Gains

Intervention and control groups improved significantly in both topics. Simulation based teaching intervention produced equal or higher learning gains, significantly so in CVS (2021–22) and RS (2022–23).

2. Long-Term Retention

Intervention groups consistently demonstrated higher retention percentages. Statistical significance achieved in CVS (2021–22). The other topic showed a positive trend but not significant.

3. Student feedback

Overall, student feedback from both cohorts indicated a positive response to the simulation-based sessions in cardiovascular shock and respiratory physiology. A majority agreed that the learning objectives were clear, sessions were enjoyable, interactive, and facilitated better understanding of complex concepts. Students appreciated the role of facilitators, effective interaction and guidance, encouragement to ask questions. While many preferred similar simulation-based sessions for future topics, a subset still favored traditional methods. Qualitative interviews highlighted teaching-learning tools like models, visualization, case scenarios. Few barriers were noted liking timing, unfamiliarity with assessments, and occasional overlap with other academic commitments.

7. DISCUSSION

Role of SBE in cardiovascular and respiratory physiology

The process of development and evaluation of simulation-based learning module to teach cardiorespiratory physiology concepts to 1st-year undergraduate pre-clinical medical students was studied. Before the introduction of the new curriculum, real-life simulation sessions in undergraduate physiology helped the students to link theory to clinical aspects of cardiovascular system. [2] In contrast to didactic lectures, the small group teaching sessions have the advantage of promoting more interaction among the students which enhance their communication levels among themselves and the teachers. [17] Various studies in India, have reported an integrated approach to teaching using simulations was beneficial to the students which gave them a comprehensive picture of learning medicine instead of compartmentalizing basic science subjects like anatomy, biochemistry and physiology as individual units. [7,18] Simulation is preferred in cardiorespiratory physiology because it allows students to visualize and interact with dynamic physiological processes such as heart rate, blood pressure, ventilation, and gas exchange that are otherwise abstract in traditional lectures.

Role of high or low technology simulators in SBE

Through high- or low-fidelity simulators, learners can observe the integrated responses of the cardiovascular and respiratory systems to physiological or pathological changes. [15] At University of Central Florida, Orlando, the web-based and mannequin simulations for learning shock physiology were conducted for 40 students, where the students rated the mannequin simulation as a more effective teaching method for pathophysiology of shock and its treatment rationale which are in accordance with the observed results of our study. [19] In concordance to the findings from our study regarding learning objective and better correlation of the content taught, a paper from USA, reports on best practices of patient simulation for medical science teaching states their four-year results of student evaluations of a cardiovascular simulation exercise, indicating high student satisfaction and perceived learning benefits in alignment with the learning objectives. [20]

The simulator is a life-size mannequin with an inbuilt physical features like breath and heart sounds, palpable pulses consisting of sophisticated mechanical and software models of the cardiovascular respiratory systems. It can be connected to standard physiological monitors to reproduce a realistic clinical environment. [17,21] Similar to our study findings of better understanding and highly engaging simulation-based teaching of respiratory physiology, a study was done on with a human patient simulator utilizing the clinical context to review fundamental concepts of respiratory physiology including the alveolar air equation and oxyhemoglobin dissociation curve. The students have perceived these exercises as superior forms of learning. [22]

A study done by Suvarna P (2022) on use of high-fidelity simulator for teaching cardiovascular physiology principles to the 1st year undergraduate medical students said that learning with the help of simulation-based activities can help the students to link basic science concepts to their practical applications. [10] Conversely, Beal et al. (2017) found that while simulation improved knowledge acquisition, it was not superior to other teaching methods. [23]

Furthermore, Akhu-Zaheya (2013) reported no statistically significant difference in knowledge gains between the groups of high-fidelity simulation and conventional teaching. [24] These discrepancies may arise from variations in study designs, teaching methods, and assessment protocols.

New appropriate assessment tools

Routinely used assessment tools or methods like MCQs, for certifying medical competency have limited ability to evaluate critical thinking and reasoning skills. Commonly used assessment tool like single response MCQs assesses only the lower order that is “knows” component of Miller’s pyramid while assessment tools like EMQs and SCT assess the “knows how” level of Miller’s pyramid which can potentially complement the other assessment tools. [25] Both SCT and EMQs are considered to be valid and reliable tools for assessing skills like clinical reasoning and judgment in medical education. [26]

Limitations of the study

1. Single-institution setting

The findings are derived from one medical college, which may limit the generalizability across various educational institutions in India.

2. Short duration of intervention exposure

Simulation-based sessions were of limited duration, and repeated exposures across the curriculum were not evaluated.

3. Potential facilitator variability

Despite training and standardized checklists, facilitator personal style could have influenced learner engagement and performance during the study period.

8. SUMMARY AND CONCLUSION

This study evaluated the effectiveness of simulation-based education or teaching learning intervention in comparison to conventional teaching in chosen topics of cardiorespiratory system among first year undergraduate medical students in two consecutive cohorts of first year MBBS students. Within the limitations of the study, we find that Simulation-based teaching in physiology significantly enhanced immediate and long-term knowledge gain compared to non-simulation teaching. The intervention was found to be feasible, acceptable, and engaging among first-year medical students and faculty. Low-cost simulation models can effectively bridge the gap theory to practice especially in alignment to NMC's Early Clinical Exposure (ECE) module.

FUTURE DIRECTIONS AND RECOMMENDATIONS

1. Simulation based education can be extended beyond cardiovascular and respiratory physiology to renal, neurophysiology, endocrine physiology.

2. A multicentric study can be planned across in multiple medical colleges to compare outcomes in diverse learning environments and to increase generalizability.

3. Long term assessments can span across the clinical years of phase II and phase III to assess whether early simulation training enhances clinical reasoning, and patient-case handling among students.

4. Creation of simulation-based education teaching modules incorporating teaching and assessment of all domains of learning that is cognitive, psychomotor and attitude will provide better student outcome.

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10. ANNEXURES

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Simulation-based teaching versus traditional small group teaching for first-year medical students among high and low scorers in respiratory physiology, India: a randomized controlled trial

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Purpose: Although it is widely utilized in clinical subjects for skill training, using simulation-based education (SBE) for teaching basic science concepts to phase I medical students or pre-clinical students is limited. Simulation-based education/teaching is preferred in cardiovascular and respiratory physiology when compared to other systems because it is easy to recreate both the normal physiological component and alterations in the simulated environment, thus a promoting deep understanding of the core concepts.
Methods: A block randomized study was conducted among 107 phase 1 (first-year) medical undergraduate students at a Deemed to be University in India. Group A received SBE and Group B traditional small group teaching. The effectiveness of the teaching intervention was assessed using pre- and post-tests. Student feedback was obtained through a self administered structured questionnaire via an anonymous online survey and by in-depth interview.
Results: The intervention group showed a statistically significant improvement in post-test scores compared to the control group. A sub-analysis revealed that high scorers performed better than low scorers in both groups, but the knowledge gain among low scorers was more significant in the intervention group.
Conclusion: This teaching strategy offers a valuable supplement to traditional methods, fostering a deeper comprehension of clinical concepts from the outset of medical training.

Keywords: Simulation training; Medical education; Medical student; India; Randomized controlled trials

Original Article

Script Concordance Test in Physiology: Preparation, Scoring, and Student Perceptions – A Mixed Method Study

Abstract

Background: Although the curriculum has changed, assessment tools are not in alignment with the new types of teaching such as early clinical exposure (ECE) and self-directed learning. Both in summative and formative assessment most commonly used tools for assessment of cognitive domain are written formats including MCQ. However, these assessment tools such as MCQ and written essays cannot assess the higher order thinking skills and clinical reasoning skills. **Materials and Methods:** The present study was conducted in the department of physiology, in collaboration with medical simulation center, as a part of formative assessment for topics on pathophysiology of shock and obstructive and restrictive lung disorders taught during ECE using case scenarios. Two script concordance tests (SCTs) each on the topic of pathophysiological mechanism of different types of shock and obstructive and restrictive lung disorders each were prepared and administered to the students. Student perception to this assessment tools was obtained. **Results:** The Cronbach's alpha of the 6-item SCT for respiratory and cardiovascular topic administered to the students (n = 107, 98) was 0.83 and 0.82, respectively. The inter-item correlation was respiratory and cardiovascular topic for 0.71, 0.69 suggesting that they are close and repetitive. Students were of the opinion that SCT are difficult to understand (75.8%), challenging to answer (47.2%), and it tested the clinical content better (71.4%). **Conclusions:** In our study, students felt though SCT tested the clinical content better when compared to conventionally used MCQ, they still find it challenging to understand and are not in favor of its use in summative and formative assessments.

Keywords: *Assessment, medical education, physiology, undergraduates*

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Introduction

It is often said that assessment drives learning. One of the principles of assessment is the alignment of teaching and learning methods to the assessment tools. Currently, in accordance with the National Medical Council guidelines, early clinical exposure (ECE) is taught to 1st year medical students in all preclinical subjects.[1] Pathophysiology of different types of shock and work of breathing in obstructive and restrictive lung disorders were taught to 1st-year medical students using case scenarios as part of their ECE module in physiology subject. The most commonly used tools in summative and formative assessment for assessment of the cognitive domain are various written formats including MCQ. However, these assessment tools such as MCQ and written essays cannot assess higher-order thinking and clinical reasoning skills.[2] Clinical reasoning has been defined as the "ability to sort through a cluster of features presented by a patient and accurately assign a diagnostic label, with the development of an appropriate treatment strategy as the end goal."[3] Till recently in India and worldwide, clinical reasoning skills were considered to be important core skills to be acquired among postgraduates in comparison to undergraduates.[4] Various studies have established that clinical reasoning is an important skill to be learned by medical students in their curriculum. It is beneficial to introduce these skills early in their curriculum and to teach periodically throughout the curriculum for better development of higher-order thinking skills and clinical reasoning skills among the graduates by the end of the course.[5] It is not easy to assess clinical reasoning skills among undergraduates as it is content-specific and requires multiple and specific assessment tools, it should be done at frequent intervals, and it should cover all the learning domains and require an ideal clinical setting. Various tools exist for the assessment of clinical reasoning skills

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Brief Report/Short Communication

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Comparison between MCQ, Extended matching questions (EMQ) and Script concordance test (SCT) for assessment among first-year medical students – A pilot study

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Abstract:

BACKGROUND: Single-best response types of MCQs are commonly used tools in medical assessment. However, these are not particularly apt for the assessment of higher-order thinking skills (HOTS) among students. Assessment of HOTS and clinical reasoning skills requires unexplored tools like extended matching questions (EMQs) and SCTs. The aim is to assess HOTS and clinical reasoning skills during formative assessment among medical students post a simulation-based education (SBE) using EMQ and SCT on the topic of shock and collect student perceptions regarding new assessment tools.

METHODS AND MATERIAL: The research is an observational descriptive study. Fifty-two first-year medical students were asked to take a formative assessment consisting of 20 MCQs, 6 EMQs, and 2 SCT post a SBE during July 2022 on the topic of shock. MCQs were categorized into themes of aetiology, pathophysiology, and management of shock. These categorized MCQs were compared and analyzed with EMQs and SCTs prepared on the same themes. The data analysis by a one-way analysis of variance (ANOVA) was conducted to compare the difference in per cent mean scores of MCQ with EMQ and MCQ with SCT.

RESULTS: The overall mean scores and also under the theme of aetiology and management, the student's score in MCQ were higher than EMQ and SCT and the difference was statistically significant with the *P* value (≤ 0.001).

CONCLUSIONS: Students scored better in familiar assessment tools like MCQ, but majority of the students were of the opinion that EMQ tested the delivered content better and SCT tested the clinical application better.

Keywords:

Clinical competence, education, medical students, shock, simulation training

Review Article

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Importance of simulation in undergraduate medical education with specific emphasis on preclinical phase – A narrative review

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Abstract:

Simulation is the answer in the current Indian scenario of more students, fewer patients, and more societal expectancy about competency from treating physicians. Incorporating simulation based training improves procedural skills, decreases patient related complications and thus enhances better clinical outcomes. Since simulation-based learning is based on experiential learning theory and deliberate practice theory, incorporating simulation-based medical education into the traditional curriculum will help us reach a desirable outcome. Simulation-based assessment is a valid and reliable tool of assessment and is used preferably in the form of OSCE/OSPE as a fundamental part of evaluation but is more commonly used for formative than summative assessment. We conducted a literature search in June 2022 in all the main databases such as Google Scholar, Web of Science, Scopus, and Medline/PubMed. It has been accepted through various sources and reports that there is a need to improve patient safety in medical practice since simulation promotes the learner-centered approach, preferably should begin from preclinical years, and activity can be designed to obtain specific learning outcomes along with providing a safe and controlled environment and there a provision for repetition of activity with focused feedback.

Keywords:

Medical education, preclinical sciences, simulation

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From the academic year 2019–2020 onward, medical education in India saw an introduction of a new curriculum called competency-based medical education (CBME) and according to the latest Medical Council of India (MCI)/National Medical Council (NMC) document, CBME stresses on early clinical exposure, electives and longitudinal care and in outcome-based undergraduate teachings of clinical skills. Communication skills, attitudes, and ethics in health care, history taking, physical examination, procedural and diagnostic skills, resuscitation skills, group dynamics, critical thinking, problem-solving, etc., are a few of the competencies which are now included in the core undergraduate curriculum.[1]

Moreover, the present CBME by the MCI/NMC (2019–2020) for undergraduates and postgraduates stresses the development of proficiency in clinical skills and not just the acquisition of knowledge.

Lacunae in the Existing Curriculum

According to the latest curriculum document, communication skills, history taking, attitudes and ethics in health care, physical examination, procedural skills, diagnostic skills, group dynamics, resuscitation skills, etc., along with clinical

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Amendment Approval letter

To

DR.NALINI Y.C

Principle Investigator

PHD - MEDICAL EDUCATION

MGMCRI

Ref: - MGMCRI/RAC/ 2021/02/IHEC/10

Project Title: AN EVALUATION OF SIMULATION - BASED TEACHING INTERVENTION IN SELECTIVE TOPICS OF CARDIORESPIRATORY SYSTEM AMONG FIRST YEAR MEDICAL STUDENTS - A CROSS OVER RANDOMIZED CONTROL STUDY

Dear DR.NALINI Y.C

We have received from you the following document(s)

1. **Protocol Version 01 Amendment 01**

At the **IHEC Full Board Review** meeting held on **19/03/2024** the above-mentioned documents were reviewed.

After consideration, the IHEC has decided to approve:

(a) The below-mentioned study-related document (Revised Protocol Version 0 1 Amendment 01)

Sl. No	Principal Investigators	Existing Provision	Proposed Amendment	Reason
1	Dr.Nalini Y C PhD Scholar – Medical Education	AN EVALUATION OF SIMULATION - BASED TEACHING INTERVENTION IN SELECTIVE TOPICS OF CARDIORESPIRATORY SYSTEM AMONG FIRST YEAR MEDICAL STUDENTS - A CROSS OVER RANDOMIZED CONTROL STUDY	AN EVALUATION OF SIMULATION - BASED TEACHING INTERVENTION IN SELECTIVE TOPICS OF CARDIORESPIRATORY SYSTEM AMONG FIRST YEAR MEDICAL STUDENTS - **A Mixed Method Study**	Title not completely reflecting in the study design

(b) The members who attended this meeting held on **19/03/2024** at which the above-mentioned document was discussed are listed below.

Sl. No	Member name	Designation in IHEC
1	Dr. Jambulingam P	Chairperson
2	Dr. Mohan Doss	Legal expert
3	Dr.Indhira	Philosopher and ethicist
4	Mrs.Prabavathi	Lay Person
5	Dr.Barathane Datchanamurthy	Member Secretary
6	Dr. Kartikeyan K	Clinician
7	Dr. Mohamed Hanifah	Clinician
8	Dr. Saravanakumar	Clinician
9	Dr.Krishna Gopal	Clinician
10	Dr. Uma Narayanamurthy	Pharmacologist

(c) After reviewing the documents, the IHEC approves the aforementioned amendment.

Yours truly,

Dr. BARATHANE D
MEMBER SECRETARY
Institutional Human Ethics Committee
MGMCRI, Puducherry - 607 402

Dr. Nalini Y C

An evaluation of simulation-based teaching intervention in selective topics of cardiovascular and respiratory system amo...

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An evaluation of simulation-based teaching intervention in selective topics of cardiovascular and respiratory system among first year medical students– A mixed method study

by Dr. Nalini Y C

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PRIMARY SOURCES

1	Nalini Yelahanka Channegowda, Dinker Ramanand Pai, Shivasakthy Manivasakan. "Simulation-based teaching versus traditional small group teaching for first-year medical students among high and low scorers in respiratory physiology, India: a randomized controlled trial", Journal of Educational Evaluation for Health Professions, 2025 Publication	3%
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